Universal Journal of Agricultural Research 10(4): 352-362, 2022 http://www.hrpub.org
DOI: 10.13189/ujar.2022.100404

Enhanced Diffusion and Scaling of Seed, Varietal Knowledge through Comparative, Experiential Learning

Swati Nayak[1,2,*], Ritesh Dwivedi[1], Manzoor Dar[3], Sk Mosharaf Hossain[2]

[1]Amity University, India
[2]Seed System and Product Management, International Rice Research Institute (IRRI), Philippines
[3]Seed System and Scaling, International Crops Research Institute for Semi-Arid Tropics, India

Received June 23, 2022; Revised August 2, 2022; Accepted August 28, 2022

Cite This Paper in the Following Citation Styles

(a): *[1] Swati Nayak, Ritesh Dwivedi, Manzoor Dar, Sk Mosharaf Hossain , "Enhanced Diffusion and Scaling of Seed, Varietal Knowledge through Comparative, Experiential Learning," Universal Journal of Agricultural Research, Vol. 10, No. 4, pp. 352 - 362, 2022. DOI:10.13189/ujar.2022.100404.*

(b): *Swati Nayak, Ritesh Dwivedi, Manzoor Dar, Sk Mosharaf Hossain2 (2022). Enhanced Diffusion and Scaling of Seed, Varietal Knowledge through Comparative, Experiential Learning. Universal Journal of Agricultural Research, 10(4), 352 - 362. DOI:10.13189/ujar.2022.100404.*

Abstract Comparative farmer field trials can be an important channel for the successful evaluation, reliable evidence, and acceptance of agricultural technologies. Farmer-managed comparative trials reinforce the agricultural extension system as they validate new technologies in farmers' field conditions. Thus, on-farm comparative trials allow the farmers to evaluate the differentiable impact of tested technology in their settings. The ingrained concept of "learning by doing" in such trials creates or improves the knowledge of farmers, and enhanced knowledge cascades into the scaling of technology. Climate resilient high yielding rice varieties are considered the most efficient solution against stagnating yields and recurrent abiotic stresses to consolidate the nation's food security. Despite the development and availability of several new varieties, farmers in South Asia, including India, continue to cultivate older varieties owing to poor varietal awareness and knowledge, especially among small and marginal farmers with less resource endowment. Therefore, awareness of the benefits of modern varieties among farmers is likely to motivate them. This concept has been ascertained by the present study. It verifies the positive effect of comparative learning of varieties through on-farm trials in the popularization of new stress-tolerant rice varieties (STRVs). Further, the impact of the gender and institutional linkage-based (through women self-help groups (SHG)) introduction of STRVs on scaling is also proven. The analysis and inferences are based on the findings of a randomized control experiment conducted in the state of Odisha in India using the STRV, BINA Dhan 11 in Head-to-Head (H2H) trials.

Keywords Diffusion, Extension, Gender, H2H, Institutional, On-Farm Trials, Scaling, Self Help Groups (SHGs), STRV

1. Introduction

Agricultural technologies, high yielding varieties (HYVs) in particular, have a progressive role in agrarian nations. The green revolution in India is a testimony to the role of HYVs in increasing agricultural yield and economic prosperity. Modern varieties also contribute positively to the non-farm sector [1]. The use of HYVs by smallholder farmers can lead to productivity gain and income enhancement [2], as they have largely been marginalized from the overall progress.

Advanced breeding programmes have successfully bred several varietal choices for farmers. A good proportion of the improved varieties is also climate-resilient, thereby offering farmers a means to mitigate the risks of climate change. STRVs are usually developed from the prevalent mega varieties through the incorporation of appropriate genes and have demonstrated impact. Past studies have confirmed that STRVs are an answer to the farming systems affected by recurrent floods and droughts [3]. Public system programmes have been emphasizing the development of such varieties [4].

As we consider the two major rice producers and consumers in South Asia, i.e., India and Bangladesh, the scale of adoption of improved varieties is unreasonably slow-paced. The demand for new promising varieties is hardly noticed in the seed chain. For example, around twenty-five varieties comprise 60% of the seed demand for crops like rice and wheat in India [5]. Most of these varieties are at least ten years old and many are as old as forty years. The dominance of such limited and old varieties is a setback given the diversity of varieties that have been developed for diverse ecologies [6]. It not only indicates the poor variety replacement scenario but also reflects the failure of traditional extension methods. The growth rate in the yield of rice and wheat declined in India in the post-globalization period with the reduction in subsidies on agricultural inputs [7]. Therefore, accelerated varietal diffusion through innovative technology transfer systems can help achieve the desired growth rate in the productivity of crops [8].

Agriculture extension systems can influence farmers toward the adoption of technologies and facilitate the desired impact. Training and participatory demonstrations play a significant role in the promotion and adoption of new varieties [9]. These methods are even more imperative from the perspective of developing or underdeveloped countries where agriculture technologies are poorly adopted but can make a significant impact [10]. Varietal choice is an important determinant of cropping systems productivity in South Asia [11]. The progressive threats from climate change entail an adaptive agriculture extension system with redefined roles and capacities [12]. Studies have established the success of gender-based strategies, institutional innovations, and stakeholder participation in knowledge creation and dissemination of technologies [13]. Rice is the predominant staple in Odisha, contributing 24.4% of INR 75000 crore annual agriculture and allied output in the state [14], however, rice farming is characterized by the dominance of traditional varieties. The existing extension methods and practices in India are largely traditional, giving farmers very little scope for validation of new technology (e.g., variety) in a comparative set up leading to slow transfer of technology. Furthermore, the significance of women's participation as a driver of a new potential variety has not been adequately studied especially for rice farming [15]. Therefore, innovation in varietal extension methods and engagement of women or their collectives in technology validation and diffusion are presumably vital for rapid diffusion and uptake of new technologies like varieties. Farmer-friendly on-farm trials with greater opportunities for performance evaluation boost varietal adoption [16]. Research findings have also indicated that gender plays a decisive role in the adoption and diffusion of a variety of farmers' interests [17]. However, the possible multiplier effect of both extension innovation and gender are not adequately studied especially in eastern India, the major rice-producing region in India [17].

2. Materials and Methods

2.1. The Study Area and Design

The study was carried out in four purposively selected districts of Odisha where submergence is a recurrent phenomenon. Odisha, a coastal belt, in particular, is adversely impacted by cyclones and floods almost every year, as witnessed in the past several decades. BINA Dhan 11 is medium maturity (120 days) rice variety and can grow without yield penalty during crop submergence at least for 14 days. This variety was introduced among the sample farmers for evaluation of the innovative extension approach, i.e., H2H trials. In contrast to current extension methods where new varieties are randomly sown in a less comparative setting, H2H on-farm trials grow and evaluate a variety adjacent to a plot of traditional and popular. Because of the same agricultural practices and crop growth conditions, any change in yield is attributed to the varieties and it is a more powerful enabler for farmers to make informed adoption decisions on test varieties. The experiment was a Randomized Control Trial (RCT) based study with distinct treatment or experiment and control groups. The primary classification as experimental and control groups was based on the H2H and non-H2H trials respectively (Table 1). There were three subgroups within each group, i.e., i) male farmers, ii) female farmers, and iii) female farmers with institutional linkage, i.e., females who are members of Self-Help Groups (SHGs). A sample size of 750 farmers was divided proportionately between the groups to ensure representation of all the intervention criteria. The selection of villages within the districts as well as the distribution of farmers into different experimental groups was done using random sampling. The data was recorded through quantitative surveys followed by qualitative interviews to ascertain and validate the findings from the former, as and when required.

Table 1. Experimental Groups and Description

	Experimental/Control Group	Description
1	T1	Female farmers who are linked to SHGs and adopted the H2H trial
2	T2	Female farmers who are not linked to SHGs and adopted the H2H trial
3	T3	Male farmers who adopted the H2H trial
4	C1	Female farmers who are linked to SHGs and didn't adopt the H2H trial (followed random sowing)
5	C2	Female farmers who are not linked to SHGs and didn't adopt the H2H trial
6	C3	Male farmers who didn't adopt the H2H trial

2.2. Measurement Framework

The study evaluated the following measurement areas by inter-group comparison

a. Varietal diffusion through different groups
b. Impact of the H2H trial in varietal spread among farmers
c. Gender-based outcomes in terms of varietal diffusion
d. Role of farmers' collective (SHG) in disseminating a new variety

The aforementioned groups were compared against each other to deduce impact measured in suitable indicators. Sample statistics were calculated for such indicators for the six experimental groups. The differences between the groups were tested for significance to infer if the on-farm trials (H2H) or gender or institutional linkage led to the changes. Based on these three different treatments, the indicators were compared between farmers with and without H2H trials, women and men farmers, and women farmers with and without linkage to community institutions. The association of the difference in statistics with the nature of the comparison groups was ascertained through the formulation of hypotheses and Chi-Square tests of association.

3. Results and Discussions

In agriculture, adoption of technology is a slow process, and even slower when the benefits are not self-observed. Risk bearing ability of the smallholder farmers is quite low, given their high dependence on the proceeds from crops in any given season. In such a scenario, the adoption of a new variety may take years to get on the farmers' field. However, farmer-to-farmer diffusion has proven to be very effective for the horizontal spread of the potential varieties. It functions through both personal observations in fellow farmers' plots and word of mouth. Nevertheless, the rate of diffusion may vary depending on the method of on-farm trial or interventions considered, as found out in the study.

3.1. Varietal Diffusion through Different Experimental Groups

Percentage of farmers from different groups who shared seeds of the STRV with others varied between 9.3% to 33.3%, i.e., a range of 24% (Figure 1). The highest share of such farmers was noted in T1 followed by T2 (16.9%). Less than 12% of farmers in the remaining groups shared seeds with others. These percentages suggest a higher extent of diffusion of seeds through women farmers collectivized through SHGs in particular, who were exposed to both H2H trials and the STRV (BINA dhan 11).

To understand the effect of the trial on the dissemination of the seeds, a multiple logistic regression model was used, as mentioned below. The dependent variable is an indicator for the sharing of seeds. The independent variables are the treatment groups and the production (quantity) of the crop.

$Y = \alpha + \beta1$ Production $+ \beta2$ Treatment arm $+ \varepsilon$; where Y is the outcome expressed as a binary variable (shared or not shared), $\beta1$ is the regression coefficient of production, $\beta2$ is the regression coefficient of the treatment categories and ε is the error term.

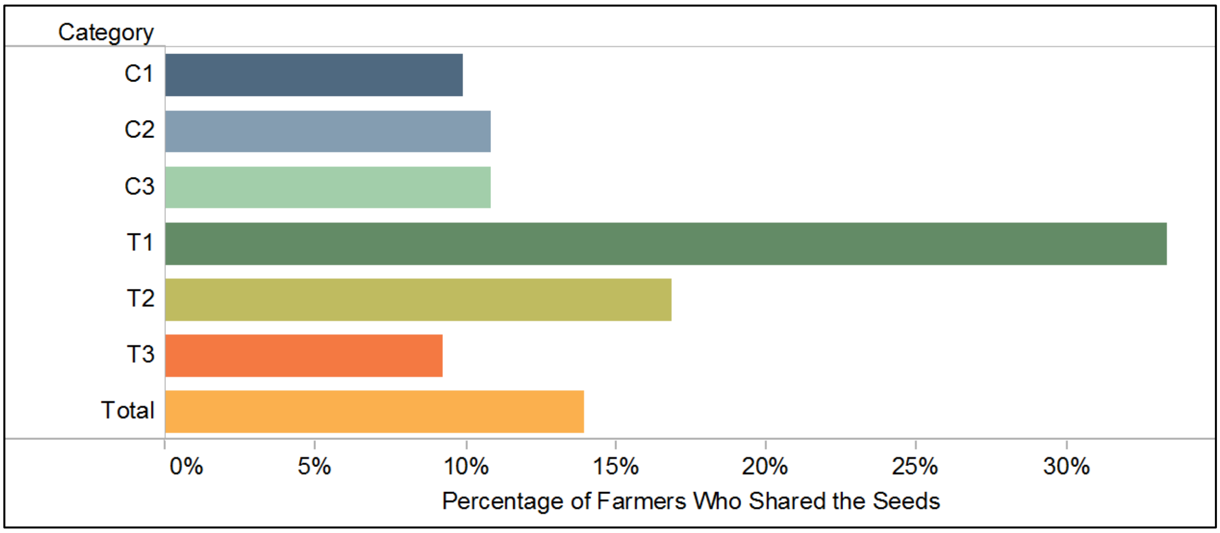

Figure 1. Proportion of farmers across groups who shared the STRV seeds

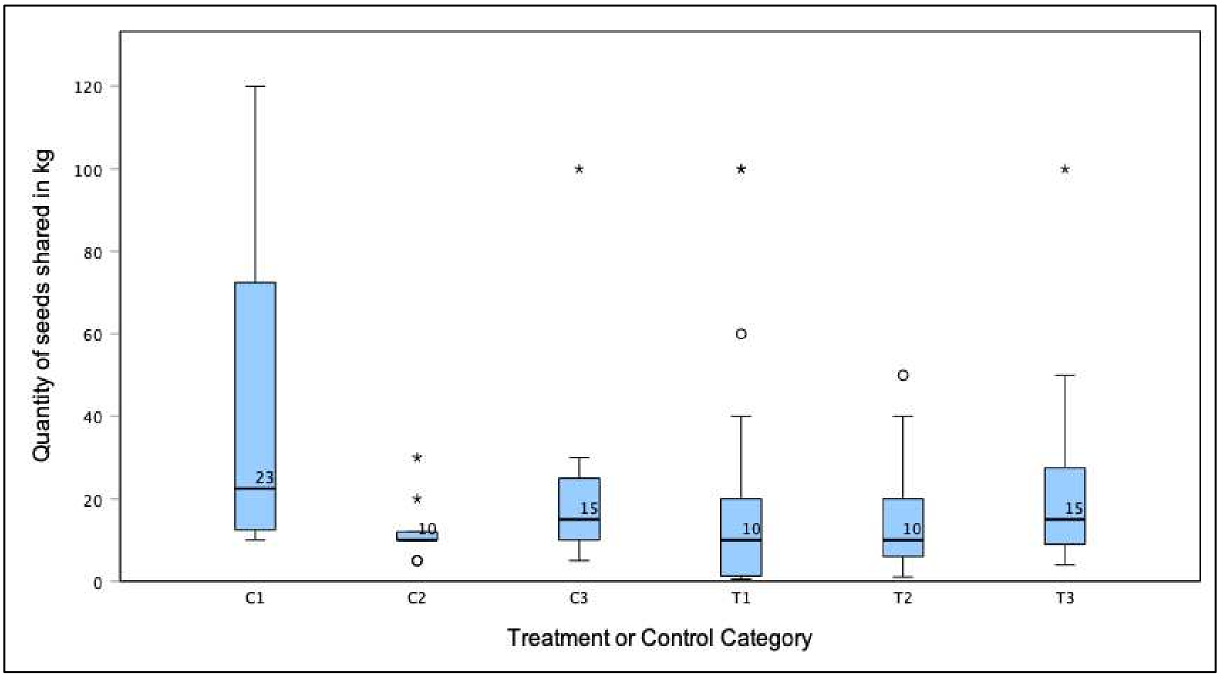

Figure 2. Quantity of the STRV seeds shared by farmers of different categories

Table 2. Effects on Seed Diffusion

Dissemination of seed			
		Coefficient	Significance
1	T1	1.377***	<.001
2	T2	.492	.202
3	T3	-.201	.586
4	C1	-.050	.912
5	C2	-.016	.970
6	Production	.107	.325

Asterisks indicate that the coefficient is statistically significant at 1%***, 5%**, and 10%* levels

The regression outputs in Table 2 show that sharing is significant in group T1, i.e., female farmers with institutional links who adopted H2H trials. Noticeably, the regression coefficient of only T1 is significant, indicating the importance of both H2H trial and SHG in the dissemination of a variety. In the case of T2, there is a moderate correlation but insignificant. Also, the quantity of production is insignificant. Thus, future extension approaches for scaling improved seeds may use a similar participant selection criterion for better results.

A simple box plot of the quantity of seeds shared by farmers from different categories (Figure 2) shows that C1 farmers shared a larger quantity of seeds compared to others who shared roughly 10 to 15 kgs on average. Results from the focus group discussions (FGDs) showed that most of the C1 farmers had not retained much for the next season and distributed a good share of the produce among SHG members.

3.2. H2H Trial-Based Difference in Varietal Diffusion

It was assumed that H2H trials accelerate the diffusion of the STRV BINA Dhan 11(hypothesis). The fraction of farmers who shared the seeds was found to be higher for the treatment arms (Figure 1). The relation of the percentages to the treatment and control groups was verified through the Chi-Square test of independence (Tables 3 and 4) at a level of significance of .05. The test output, $p < .05$, confirmed a significant association between treatment and control groups and sharing of the seeds.

The below analysis establishes higher diffusion of the STRV when introduced through H2H trials. Given the unique design and layout of the H2H trial, the varietal impact is more pronounced and it creates a ripple effect for other farmers to observe and decide on the adoption of the variety. To experiment with the new variety, they reach out to the participant farmers for the farm-saved seeds. H2H trials are highly effective as farmers can discern the difference in yield or other traits that can be accounted for by the variety alone as every other cropping factor remains the same.

Table 3. Contingency table for H2H trial-based difference in varietal diffusion

Category		If shared Bina 11 seeds with others		Total
		Yes	No	
H2H	Count	57	272	329
	% within row	17.3%	82.7%	100.0%
Random	Count	35	295	330
	% within row	10.6%	89.4%	100.0%
Total	Count	92	567	659
	% within row	14.0%	86.0%	100.0%

Table 4. Chi-Square test output for H2H trial-based difference in varietal diffusion

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.192	1	.013*		
Likelihood Ratio	6.244	1	.012		
Fisher's Exact Test				.014	.009
Linear-by-Linear Association	6.183	1	.013		
N of Valid Cases	659				

* Test for the hypothesis being one-tailed, the p-value for the test will be ½* .013

3.3. Gender-Based Difference in Varietal Diffusion

The study supposed that farmers' gender has no role in determining there is no difference in the diffusion of the STRV. In terms of the ratio of farmers who distributed seeds of the STRV, there was a difference between male and female farmer categories, i.e., nearly 18% in the case of females and 10% in the case of males. The supposition that diffusion was wider in the case of female participants was tested through the Chi-Square test of independence (Tables 5 and 6) at a level of significance of .05. The test output, $p < .05$, established a significant association between the gender of farmers and sharing of the seeds. These findings have strong implications since women farmers are custodians of seeds (Nayak et al., 2021) and are more likely to share the seeds compared to their male counterparts.

3.4. Institutional Association-Based Difference in Varietal Diffusion

The selection of institutional connections as a criterion for intervention was based on the hypothesis that diffusion of a new variety is faster when introduced through female farmers with such linkages. Analysis of field findings indicated a greater extent of sharing of the seeds by members of SHGs (21.8%) compared to those who are not members of the SHGs (13.9%). The assumption was tested through the Chi-Square test of independence (Tables 7 and 8) at a level of significance of .05. The test output, $p < .05$, established a significant association between an institutional connection between farmers and sharing of the seeds.

Table 5. Contingency table for gender-based difference in varietal diffusion

Category		If shared Bina 11 seeds with others		Total
		Yes	No	
Female	Count	59	272	331
	% within row	17.8%	82.2%	100.0%
Male	Count	33	295	328
	% within row	10.1%	89.9%	100.0%
Total	Count	92	567	659
	% within row	14.0%	86.0%	100.0%

Table 6. Chi-Square test output for gender-based difference in varietal diffusion

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.267	1	.004*		
Likelihood Ratio	8.368	1	.004		
Fisher's Exact Test				.005	.003
Linear-by-Linear Association	8.255	1	.004		
N of Valid Cases	659				

*Test for the hypothesis being two-tailed, the p-value for the test remains .004

Table 7. Contingency table for institutional association-based difference in varietal diffusion

		If shared Bina 11 seeds with others		Total
		Yes	No	
SHG	Count	36	129	165
	% within row	21.8%	78.2%	100.0%
Non-SHG	Count	23	143	166
	% within row	13.9%	86.1%	100.0%
Total	Count	59	272	331
	% within row	17.8%	82.2%	100.0%

Table 8. Chi-Square test output for institutional association-based difference in varietal diffusion

Particular	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.582	1	.058		
Likelihood Ratio	3.606	1	.058		
Fisher's Exact Test				.063	.040
Linear-by-Linear Association	3.571	1	.059		
N of Valid Cases	331				

Test for the hypothesis being one-tailed, the p-value for the test will be ½.058

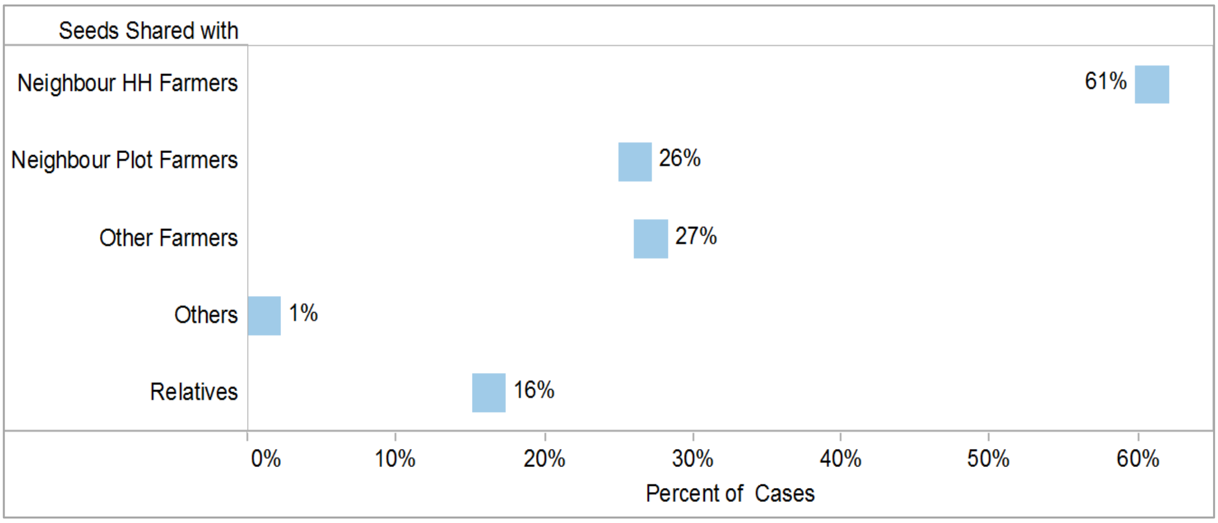

Figure 3. Stakeholders who received seeds of the STRV

Community collectives such as SHGs can play an important role in catalysing the effect of extension approaches used for the dissemination of varieties. Such institutions offer a platform for the spread of knowledge and awareness. Further, members within a group act as an assured source of supply when other fellow members opt to try a new variety.

3.5. Interaction of the Factors - Geography, Gender, and Institutional Association

The experimental seeds were shared with the farmers in the neighboring households in the intervening villages (61% of total cases) (Figure 3). Therefore, the sharing of seeds was largely within the same village (Figure 4). The instances where the seeds were shared with someone from a different administrative block involved relatives or networks of SHGs. However, the fact that seeds were shared with farmers from different villages (29.3% of total cases) hints at the potential for faster diffusion through on-farm trials.

A gender-based crosstabulation of the source and recipients of the STRV seeds revealed some noteworthy facts (Table 9 and Figure 5). Most of the receivers were males (more than 75%) and most of the sources were females (64.1%). This was corroborated by the finding that males have a greater say in decisions related to varietal choice as well as procurement. Therefore, the possible choice of BINA Dhan 11 for the next Kharif cropping season was mostly decided by the male members of the farming households. Male farmers (who were not part of the trial) obtained seeds from both male and female participant farmers while female farmers (who were not part of the trial) got the seeds mainly from female participant farmers. Male farmers hardly shared the seeds with female recipients (less than 5%). Female to female sharing was facilitated through social cohesion and SHG linkages. Among females, both the sources and the recipients were largely from SHGs (Table 10). 77.3% of women who shared the seeds with other women belong to SHGs. Additionally, 77.3% of the women sources were members of SHGs. Considering the diffusion between members of SHGs, intra-group sharing was much higher (72.2% of cases) than inter-group sharing (Figure 6).

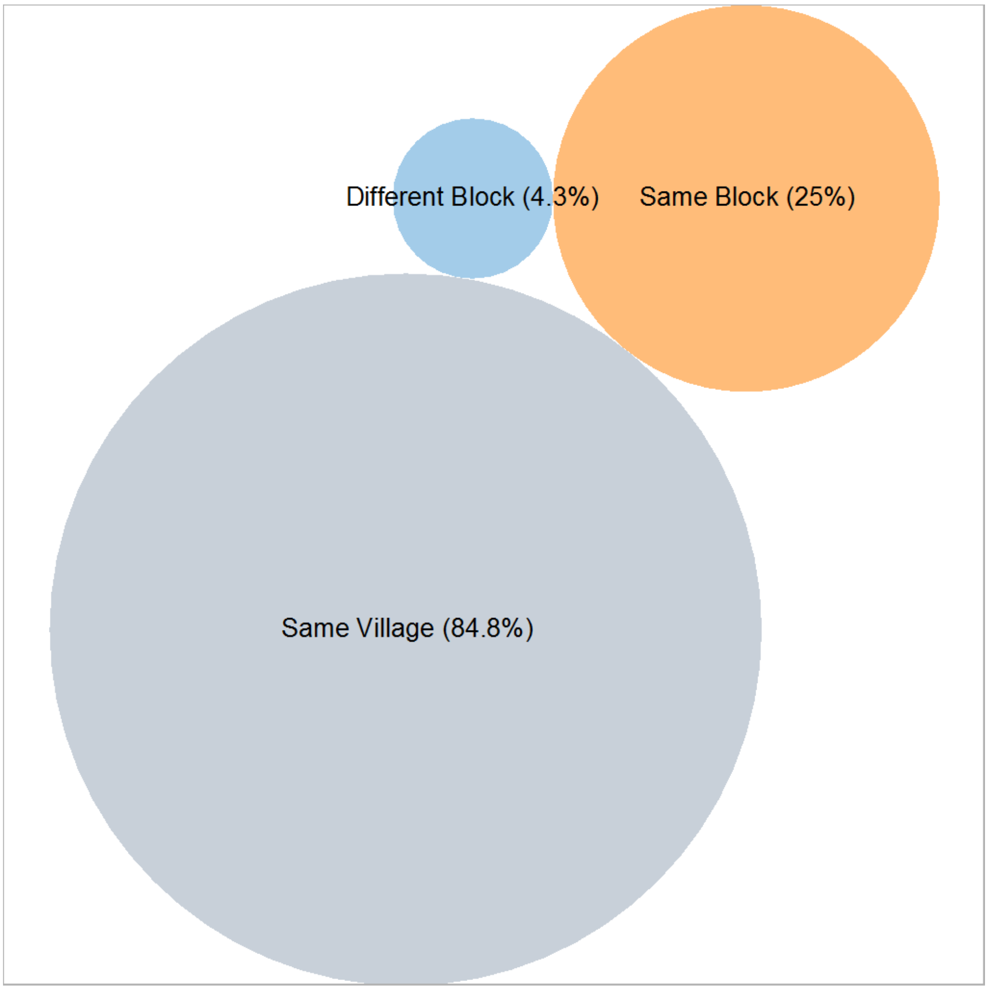

Figure 4. Location of the stakeholders who received seeds of the STRV

Table 9. Crosstabulation of the gender of farmers who shared and who received the STRV seeds

Gender of the farmers who shared the STRV seeds		Gender of the farmer with whom the STRV seeds were shared			Total
		All male	All female	Both female and male	
Female	Count	37	16	6	59
	%within row	62.7%	27.1%	10.2%	100.0%
	%within column	54.4%	94.1%	85.7%	64.1%
Male	Count	31	1	1	33
	%within row	93.9%	3.0%	3.0%	100.0%
	%within column	45.6%	5.9%	14.3%	35.9%
Total	Count	68	17	7	92
	%within row	73.9%	18.5%	7.6%	100.0%
	%within column	100.0%	100.0%	100.0%	100.0%

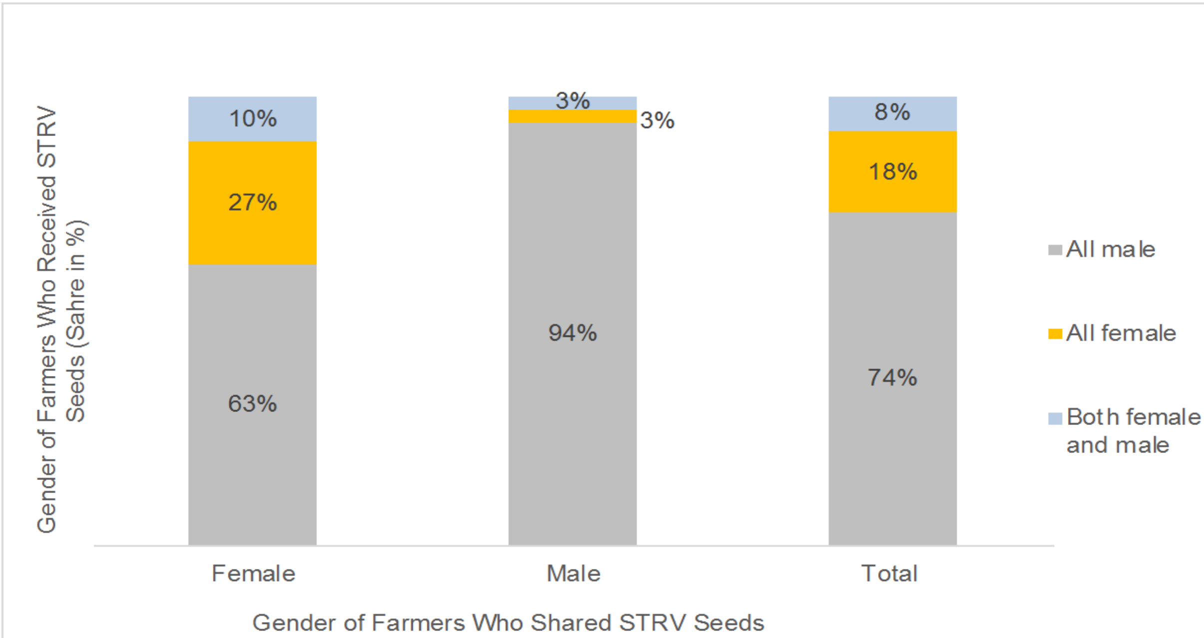

Figure 5. Gender relation in the diffusion of the STRV seeds

Table 10. Crosstabulation of the institutional linkage of farmers who shared and who received the STRV seeds

Institutional linkage of the female farmer who shared the STRV seeds		Institutional linkage of the female farmer who received the STRV seeds			Total
		SHG	Non-SHG	Don't know	
SHG	Count	13	0	4	17
	%within row	76.5%	0.0%	23.5%	100.0%
	%within column	76.5%	0.0%	100%	77.3%
Non-SHG	Count	4	1	0	5
	%within row	80.0%	20.0%	0.0%	100.0%
	%within column	23.5%	100.0%	0.0%	22.7%
Total	Count	17	1	4	22
	%within row	77.3%	4.5%	18.2%	100.0%
	%within column	100.0%	100.0%	100.0%	100.0%

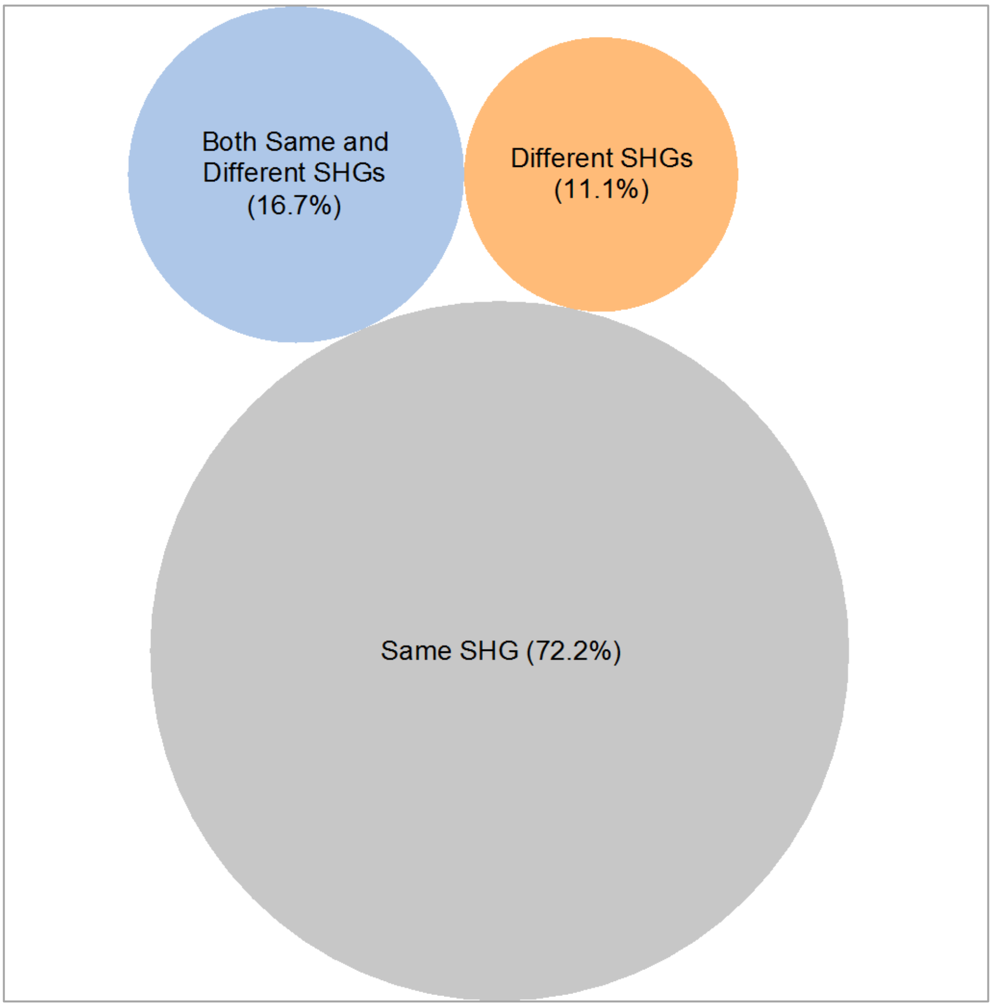

Figure 6. Intra and inter-SHG diffusion of the STRV seeds

4. Conclusions

The study produced evidence that H2H trials are an effective tool for scaling new varieties. Simultaneous planting of new varieties in the plots adjacent to each other allows for an easy evaluation of its relative advantages and it triggers adoption. A season-long observation leads to improved knowledge of varietal differences. Thus, the varietal adoption becomes well-informed and self-evaluated instead of an uninformed choice. The efficacy of on-farm trials is further strengthened through the selection of appropriate intervention channels, such as gender, collectivization, entrepreneurship, etc. This study also explored such multiple options. Women were found to be more active than men in the sharing of the seeds. While female farmers got the seeds mostly from other female farmers, males got the seeds from both. Institutional associations of women are a significant factor, as evident from the extent of sharing between members of SHGs. In a nutshell, collectivized women farmers exposed to the H2H trial exhibited improved varietal diffusion and seed scaling.

The current practice of free distribution of potential varieties may not ensure their scaling. Innovative extension approaches need to be developed considering the prevalent gender roles, socio-cultural settings, and needs of the society. A wider implication of this study could be the incorporation of the learnings in public sector extension systems. Despite a large number of private players today, farmers in developing economies like India rely on public sector extension services to a large extent for the supply of seeds. The use of innovative concepts like comparative learning through H2H trials, community institutions-based scaling of technologies, and encouraging women to be part of technology trials can lead to the bigger goal of a gender-sensitive society with the required knowledge base to absorb new technologies.

REFERENCES

[1] Hazell, B.R.; Peter, Ramasamy, C.; Aiyasamy, P.K. The green revolution reconsidered: the impact of high-yielding rice varieties in South India. Baltimore, MD: Published for the International Food Policy Research Institute (IFPRI) by

Johns Hopkins University Press. 1991.

[2] Besley, T.; Case, A. Modelling technology adoption in developing countries. *The American Economic* Review. 1993, 2, 396-402. 83(2): 396-402.

[3] Dar, H.M.;Singh, S.;, Singh, S.U.; Zaidi, W.N.; Ismail, M.A. Stress Tolerant Rice Varieties - Making Headway in India. SATSA Mukhapatra - *Annual Technical Issue*. 2014, 18, 1-14.

[4] Mackill, D.J.; Ismail, M.A.; Singh U.S.; Labios R.V.; Paris T.R. Development and Rapid Adoption of Submergence-Tolerant (Sub1) Rice Varieties. *Advances in Agronomy*. 2012, 115, 299-352.

[5] Singh, R. Varietal replacement rates among field crops: current status, constraints, impact, challenges and opportunities for the Indian seed industry. *Seed Times*.2015, 7,71-90.

[6] Singh, R.P.; Chintagunta A.D.; Agarwal, D.K.; Kureel, R.S.; Kumar, S.P.J. Varietal replacement rate: Prospects and challenges for global food security. *Glob Food Sec*. 2020,25, 100-324.

[7] Ahmad, F.MD.; Haseen, S. The performance of India's food grain production: A pre and post reform assessment. *International Journal of Scientific and Research Publication*. 2012, 3.100-117

[8] Janaiah, A.; Hossain, M.; Otsuka Keijiro. Productivity impact of the modern varieties of rice in India. *The Developing Economies*. 2006,2, 190-207.

[9] Ghimire, R.;Wen-chi, H.; Shrestha, B.R. Factors affecting adoption of improved rice varieties among rural farm households in Central Nepal. *Rice Science*. 2015, 1, 35-43; 22(1): 35-43.

[10] Faltermeier, L.; Abdulai, A. The impact of water conservation and intensification technologies: Empirical evidence for rice farmers in Ghana. *Agricultural Economics*. 2009, 3, 365-379; 40(3): 365-379.

[11] Nayak, S.; Dwivedi, R.; Hossain, M.H.; Das.; Saxena, M. Varietal Diversity, Seed Security and Adoption Dynamics of Rice Farmers in Eastern India. *Universal Journal of Agricultural Research*. 2022, 2, 145 - 155. DOI: 10.13189/ujar.2022.100206.

[12] Davis, K.; Sulaiman, R. The New Extensionist: Roles and Capacities to Strengthen Extension and Advisory Services. *Journal of International Agricultural and Extension Education*. 2014, 3, 6-18.

[13] McDougall, C.; Ojha, H.; Hall, A.; Sulaiman, R. Adaptive collaborative approaches in natural resource governance: rethinking participation, learning and innovation, edited by Hemant R. Ojha, Andy Hall and Rasheed Sulaiman V. *Critical Policy Studie*s. 2015, 3, 383-385.

[14] Samrudhi-Agriculture Policy, *Government of Odisha India*, 2020. https://agri.odisha.gov.in/policies-and-packages

[15] Nayak, S.; Dwivedi, R.; Dar, M.H. Creating marketing linkages for new climate resilient rice varieties through innovative agriculture extension method. *International Journal of Business and Globalization*. 2020, 1,4-6. 10.1504/IJBG.2020.10032640

[16] Nayak, S.; Habib, M.A.; Das, K.; Islam, S.; Hossain, S.M.; Karmakar, B.; Fritsche Neto, R.; Bhosale, S.; Bhardwaj, H.; Singh, S.; et al. Adoption Trend of Climate-Resilient Rice Varieties in Bangladesh. *Sustainability*. 2022, 14, 5156. https://doi.org/10.3390 /su14095156

[17] Dar, M. H.; Waza S. A.; Nayak, S.; Chakravorty, R.; Zaidi, N.W.; Hossain, M. Gender focused training and knowledge enhances the adoption of climate resilient seeds. *Technology in society*. 2020,63,101-388.https://doi.org/10.1016/j.techsoc.2020.101388